Water Quality and Beef Sustainability

Dr. Dan Loy,[1] Dr. Patrick Gunn,[2] and Dr. Dan Anderson[3]
[1]Professor of Animal Science and Director of the Iowa Beef Center • [2]Assistant Professor of Animal Science, Extension Cow-calf Specialist • [3]Assistant Professor of Agricuture and Biosystems Engineering, Extension Manure Management and Water Quality Specialist
Collaborators: **Dr. Jim Russell,[1] Shawn Shouse,[2] and Erika Lundy[3]**
[1]Professor Emeritus of Animal Science • [2]Extension Field Engineer • [3]Extension Beef Program Specialist

Introduction

Water quality plays a vital role in everyday life as a source of drinking water for people and livestock, recreation, and providing a healthy ecosystem. Surface water is an important component of these needs and drives regional livestock production practices. Due to their role in utilization of pasture and range, cattle are widely dispersed across the landscape of the United States in both a grazing and feedlot capacity. Thus, it is clear that maintaining and improving water quality is an essential component of sustainable beef production. As such, producers have a vested, direct interest in maintaining water quality for both their cattle and the ecosystem.

Overview of Water Quality and Beef Production

The United States has over 3.5 million miles of rivers and streams, 41 million acres of lakes, reservoirs, and ponds, 87 thousand acres of bays and estuaries, and 58,000 miles of coastal shoreline. The U.S. Environmental Protection Agency (EPA) has estimated that 55-77% of these waters are threatened or impaired, identifying agriculture as a probable cause of impairment in as much as 23% of these waters. Sources of impairments related to agriculture include nutrients, specifically phosphorus and nitrogen, sediment, and pathogenic bacteria.

As of the latest Census of Agriculture in 2012, 40% of all U.S. land was in agricultural production, with beef cattle farming and ranching noted as the largest agricultural production sector, accounting for over 600,000 farms. These statistics illustrate the diversity of cattle operations across the United States, and coupled with the surface water data previously presented, it is clear that cattle are often in proximity to surface waters. Of the 915 million acres of farmland identified in 2012, 45% was in permanent pasture or rangeland that often is transected or borders riparian areas. Feedlots, while not directly in contact with surface waters, provide potential water impairments that must be contained through proper management of runoff.

Box 1. Ecological benefits of grasslands include:

- Reduced erosion in comparison to croplands due to continuous, year-round cover of soil (above-ground plants and their roots hold soil in place)
- Improved water infiltration due to vegetation and litter on soil surface that decreases impact of raindrops, as raindrops hitting bare soil can cause compaction and the formation of a crust
- Sequestration of nutrients due to the continuous plant cover and lack of soil disturbance relative to croplands
- Improved soil health through decreased soil disturbance, increased soil cover, and a longer growing period for plants within a year compared to croplands

Grasslands are valued for the ability to improve water quality by reducing erosion by as much as 74% in comparison to cropland. In addition, grasslands also have other ecological benefits including improved water infiltration, sequestration of nutrients and improved soil health (see **Box 1**). In many cases, land use decisions that convert vulnerable lands and soils from cropland to pasture or forage production have positive benefits for water quality. However, negative impacts of grazing on water quality have been identified through research, most often due to overgrazing or extended exposure to riparian areas due to excessive stocking rates or poor cattle distribution.

Sources of water impairments in grazing systems include streambank erosion, sheet and rill erosion, gully erosion from riparian and upland regions of pastures, streambed resuspension, and direct fecal and urine deposition. Pollution from these sources are often natural processes that may be enhanced by excessive exposure to grazing cattle by high stocking densities within riparian areas because of pasture size, shape, and slope and distribution of forage, water, and shade. However, with proper management, strategies can be implemented to reduce the impact of cattle on water quality in grazing systems including implementation of streambank buffers and grazing exclosures and altering stocking density to correspond to forage availability (**Figure 1**). Other beneficial management practices include the use of rotational and controlled grazing systems as well as strategic placement of supplemental feed or mineral sources and off-stream watering systems to allow for more uniform cattle grazing distribution. Because nonpoint source pollution of surface waters is influenced by soil characteristics, topography, vegetation, climate, and wildlife, the efficacy of practices to reduce sediment, nutrient, and pathogen loading of surface water sources will be site-specific even within nearby regions.

In confined beef systems, the potential sources of water quality impairment relate to direct runoff of water from the surfaces of feedlots into streams or other surface waters as well as the storage, management and distribution of solid manure. Potential pollutant sources from confined cattle feeding operations include feedlot runoff from production areas exposed to precipitation events including outdoor pens, manure stacking areas, and feedstuff storages, but also include runoff from manured fields.

In all confined animal feeding systems, proper management of rainfall onto the production facility is critical for protection of surface waters. Practices implemented by cattle producers include feed storage under roof, providing cattle housing under roof, and implementation of water diversions, berms, and gutters on the production buildings to help direct clean water around critical production areas and away from potential sources of contamination. In some cases, it is not possible to eliminate all potential contact between rainfall- and rainwater-induced runoff and nutrient sources (manure and feedstuffs), and in these cases producers provide control and treatment to the runoff water through practices including solid settling, vegetative filtration, controlled infiltration, or total collection

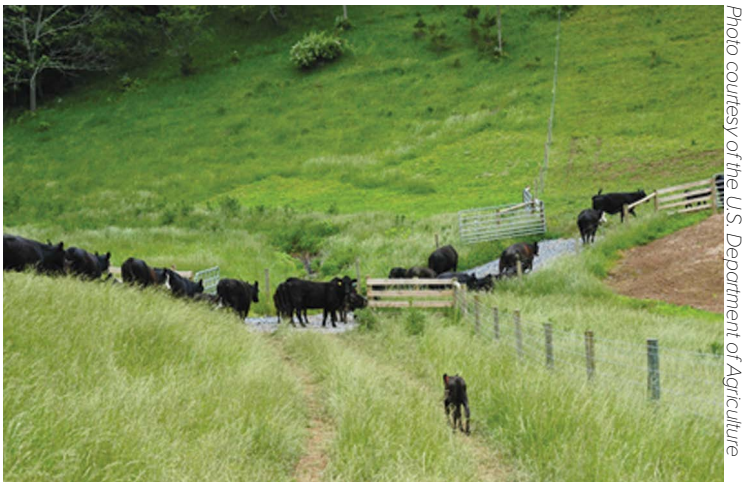

Photo courtesy of the U.S. Department of Agriculture

Figure 1. *Example of a constructed stream bank crossing area for beef cattle. Stream crossings help keep stream banks intact and nutrients out of waterways.*

and irrigation or enhanced treatment of the runoff water to reduce or eliminate pollution potential. The method selected is typically dictated by operation size, proximity to and sensitivity of surrounding surface waters, and climates and soils of the region.

In addition to controlling rainwater-induced runoff from the animal feeding operations, management of the animal manure is critical for both protection of water quality and for farm sustainability. Despite improvements in animal nutrition, only about 10-30% of the nitrogen and phosphorus cattle are fed is retained in the animal with the rest excreted in the manure. Depending on the type of confinement site used and the management practices related to manure storage and land application utilized, nutrient concentrations in the manure and the nutrient's ability to

Photo courtesy of Iowa Cattlemen's Association

Cattle graze on cover crops in an Iowa corn field. Cover crops can protect water quality by scavenging nitrogen and reducing erosion, while also serving as a source of feed for cattle.

be recycled can vary greatly. In general, manure-handling systems can be separated into three types for cattle confinements, open lots (concrete and earthen lots with or without sheds), deep pit confinement barns, and bedded confinement facilities (including hoop barns, mono-slopes, and gabled roof buildings). While the amount of nutrients excreted per animal will be similar at all operations, the nutrients retained in the manure until land application can vary considerably, with nutrient retention generally highest in deep pitted barns, followed by bedded confinements, and then open lots.

As a result of the large percentage of nutrients that end up in the manure, nutrient management planning is a key component of protecting water quality. Nutrient planning at state and regional levels is necessary to ensure there is adequate crop capacity in a given area to utilize all manure nutrients as a fertilizer resource. Recent studies have shown that most areas still have sufficient land available to recycle manure nutrients effectively. In addition, nutrient planning at the farm level is necessary to ensure appropriate application decisions are made, with many farms implementing nutrient plans based off nitrogen and phosphorus recommendations and soil sampling results (**Figure 2**). To make the most of these plans, farms must understand them and take annual soil and manure samples to update application strategies, calibrate the application equipment to ensure the suggested application is met and to ensure uniform manure distribution, and evaluate current soil and weather conditions to determine the most appropriate application timing.

Photo by Lynda Richardson, USDA Natural Resources Conservation Service

Figure 2. *A National Resources Conservation Service (USDA-NRCS) employee collects a soil sample in Virginia. Eighty-three percent of beef producers who responded to the survey sampled their soil at least once every 4 years. Soil nutrient analysis is a key component of nutrient management planning and necessary for applying manure and synthetic fertilizers at agronomic rates (amounts the plants need, while minimizing risks of nutrient leaching and runoff).*

U.S. Beef Producers Adoption of Water Quality Improvement Practices

A survey of U.S. beef cattle producers was conducted as a component of this review to determine the extent of practices implemented at the farm- and ranch-level to improve water quality. The completed surveys represented managers of more than 4.39 million animal units and 14 million acres of land, and 99.8% of the respondents employ at least one water quality improvement practice (**Table 1**).

Table 1. *Results from a national survey of U.S. beef producers.*

Item	Value
Total respondents	759
Animal units represented	4.39 million
Acres represented	13 million
Percent of respondents implementing at least 1 water quality improvement practice	99.8%

The top water protection practices implemented by graziers were providing water sources away from surface water (73% of respondents), providing feed or supplementation sites away from surface water (70%) and implementation of a grazing plan or prescribed grazing (67%). For feedlots or beef cow operations that confine cattle during portions of the year, the water protection practices most frequently indicated were locating temporary feeding areas in locations with good erosion control and away from water sources (61%), frequently removing manure away from temporary feeding areas (41%) and filtering runoff from pens/manure accumulation areas through a permanently vegetated grass buffer area (36%). It should be noted that, with few exceptions, feedlots large enough to be required to have a National Pollutant Discharge Elimination System (NPDES) permit are required to collect all runoff in retention basins (**Figure 3**). For beef cattle operations that also manage cropland, most frequently implemented water quality protection practices were soil testing every 4 years (83%; **Figure 2**), utilization of no-till or minimum till farming methods (77%) and use of soil conservation practices such as grass waterways, filter strips and terraces as appropriate. Of the respondents to the survey, 99% of beef producers are taking steps to protect surface water quality and 56% had taken advantage of government cost share or incentives.

Photo by Jeff Vanuga, USDA Natural Resources Conservation Service

Figure 3. *Cattle at a feedlot in Yuma, Arizona. Virtually all confined beef operations that have a capacity of 1,000 animals or greater in the United States are required to have a comprehensive nutrient management plan and collect 100% of their runoff from the operation. These practices help protect water quality.*

Cattle, like all animals excrete nutrients and microorganisms that can be pollutants at significant concentrations. Management practices (many of them site specific) exist to protect surface waters from these pollutants in cattle operations. Many of these practices involve maintenance of adequate vegetation within pastures and rangeland or around feeding facilities or fields where manure is spread.

In many cases the nutrients in animal manure are used as a resource for crop production, thus reducing the need for the same nutrients from chemical fertilizers. Beef producers are aware of practices that improve water quality and are adopting them. Through continued education on practices and self-assessment, beef cattle producers can sustainably produce safe, affordable beef while protecting surface water quality.

BEEF

Funded by the Beef Checkoff.

For more information, contact:
National Cattlemen's Beef Association
Contractor to the Beef Checkoff Program
9110 East Nichols Avenue
Centennial, CO 80112
303.694.0305